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(72) Applicant and Inventor: SABEE, Reinhardt, N. [US/US]; 728 South Summit Street, Appleton, WI 54911 (US).

Agents: FULLER, Henry, C. et al.; 633 West Wisconsin Avenue, Milwaukee, WI 53203 (US).

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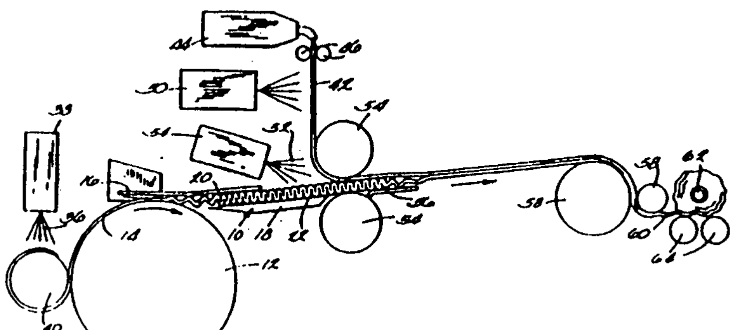

Abstract

A creping or gathering process is performed on an elongatable but relatively non elastic web. This gathering process may be formed by any of a number of creping apparatus commercially available. Once the non-elastic web (14) is gathered, it is [joined] to a nonwoven elastic web, formed of nonrandom-laid continuous filaments (42) to produce an elasticized gathered non-[elastic] fabric. This fabric is then subjected to tension and thus stretched and elongated so as to remove most or substantially all of [the gat]hers from the pregathered web. Finally, the elasticized nonwoven fabric is released from the tension, relaxing the fabric, hereby permitting some or all of the gathers of the non-elastic web to reform.

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Elastic composite material and method for its prodn. - comprises non woven elastic web joined to a gathered non-elastic web (Eng)
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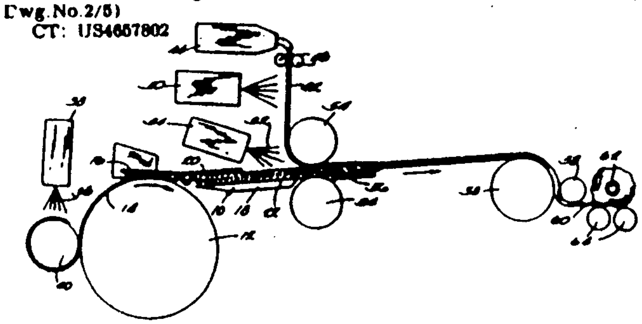
ADVANTAGE - Extremely light weight elastic fabrics are formed which are gentler and less constrictive to the user. (37pp Dwg.No.2/5)
CT: US4657802



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ELASTICIZED PREGATHERED WEB

Background of the Invention

This invention relates to elasticized fabric and processes and apparatus for preparing elasticized fabrics, and particularly to such a fabric which is elongatable to a very great degree wherein the web integrity does not suffer from web and fiber separation upon the application of a stretching force.

There has been a great need for a less critical process to produce elasticized webs having an improved quality and a predetermined controlled porosity for water repellency, breatheability and drapability at a lower cost than has been heretofore available. There is also a great need for a process which does not degrade the elastomeric polymers to as great an extent as that which occurs in the melt blown or spray spun process during the formation of fibers or filaments, in order that lower cost elastomers may be utilized.

Morman, U.S. Patent No. 4,657,802, discusses the problem of cohesiveness associated with the melt blown elastomeric fibrous webs and whether, upon laydown on the surface of a porous screen, the melt blown microfibers are sufficiently cohered to each other to form a cohesive web capable of performing the

stretching and relaxing steps without being adversely affected (i.e. the web separates and loses its integrity, upon the application of a stretching force). The cohesion of the microfibers to each other is disclosed to be increased by elevating the nip roll temperature. This nip roll temperature is varied depending upon the degree of cohesion desired, and the cohesive characteristics of the material used to form the microfibers.

Jones et al., U.S. Patent No. 4,355,425, discusses a process to make melt blown fabrics from Kraton G rubber, an A-B-A block copolymer, which melt-fractures and degrades into nonelastic materials at melt blowing fiberizing temperatures. The patent teaches that relatively large amounts of a viscosity reducing agent, such as a fatty acid, should be used to lower the extrusion temperature by reducing the viscosity of the TPE resin melt. There is, however, the disadvantage that additives such as fatty acids must be extracted from the final product, such as by dissolving the fatty chemicals in the fibers, in an isopropyl alcohol bath.

Another method is the use of a blanket of non-oxidizing gas to reduce the polymer oxidation, which is a major cause of the problems encountered in processing TPE polymers at the high temperatures associated in the fiber blowing phase of the melt-blowing process. This blanketing of the resin in the fiber-forming stage limits the oxidative degradation of the extrudable TPE resin. Morman, U.S. Patent No. 4,692,371, describes a method for making an elastomeric material which may be heated to temperatures high enough to normally degrade the material, about 600°F (315°C), to form fibers by extrusion through a plurality of extrusion orifices into a gas stream. As there

disclosed the gas stream is formed of an inert or at least a non-oxidizing gas such as nitrogen, which attenuates the extrudate from the orifices to produce elastomeric fibers using the melt blown process as described above and more completely described in Butin, U.S. Patent No. 3,849,241, which is incorporated herein in its entirety by reference.

A different process for producing these fibers, referred to as the melt spun process, consists of simultaneously spinning a multiple number of continuous filaments of synthetic polymer such as polypropylene through multiple spinning nozzles or spinnerets, preferably extending in one or more rows. The polymer is melted in an extruder and the melt delivered by pumps to the spinning equipment which include spinning nozzles for the extrusion of molten polymer to form the desired filaments. The filaments are then directed through a quench chamber into the nip of a pair of temperature controlled draw rolls which feed the downstream processing equipment. The melt spun process is explained more fully in Dorschner, U.S. Patent No. 3,692,618, and Sabee, U.S. Patent No. 4,910,064, both of which patents are incorporated herein by reference in their entirety.

The melt spun process permits use of much lower temperatures for processing extrudable thermoplastic polymers than does the melt blown process. The reason for this temperature difference is that the melt spun process requires temperatures only high enough to melt the polymer to extrusion temperatures, whereas the melt blown process requires much higher temperatures in order to thermally degrade the polymer to fiberizing viscosities and to provide the high temperature, high velocity air streams necessary to attenuate and fiberize the molten and degraded fiber-

forming polymer, as described in Butin, '241.

As can be seen from the above, the prior art teaches the use of the melt blown random laid fibrous process and the melt spun random laid continuous filament process for the production of elasticized fabrics. Since both processes are random laid, and since complete randomness is rarely if ever accomplished in random laid webs, both processes have the inherent characteristic of forming non-uniform webs, particularly in the light weight fabrics, with respect to uniformity, opacity, porosity, basis weight, and machine direction-cross direction tensile strengths throughout the web. Accordingly web weights have to be increased to give the non-uniform fabric more of a semblance of uniformity in opacity, porosity, basis weight, tensile strengths, and appearance, and to meet minimum requirements of the final product specifications, thereby adding to the product cost, weight, and stiffness.

Elastomeric webs prepared from melt blown elastomeric fibers and filaments have a random laydown pattern, and as a result form a layer of entangled and intertwined fibers lying in nearly infinite different directions. Accordingly, when these elastomeric fibers are used to provide the elasticized element in a fabric such as, for example, an elastic bandage or dressing which in actual use is extended or contracted in one direction, a large percentage of the elastic fibers are not stretched or extended. Those lying in the direction of extension, such as longitudinal, will be stretched the most, and the elastic fibers lying in the transverse direction will be stretched the least, with the elastic fibers oriented in directions between the longitudinal and the transverse being stretched amounts varying with their direction of orientation.

A large portion of the elastic fibers between the longitudinal and transverse directions are not stretched or extended, and if they are extended, it is only to a fraction of their capabilities. This inefficiency in the ability to use the full potential of the extensibility of the melt blown elastomeric fibers results in the necessity to use larger quantities of elastomeric fibers to provide the required contractive force to retract an extended fabric to its pre-extended length.

In addition to the increased cost incurred by using additional fibers to obtain the necessary tensile strength to produce the gathers, there is an additional negative factor as a result of using the melt blown process to form a random laid elastomeric web, in that the additional thickness has a deleterious effect on the drapability and hand of the fabric.

It will be appreciated that a degree of elasticity is one important consideration in forming composite fabrics such as those of the present invention, particularly when such composites are to be utilized in garments which are designed to conform to the body of the wearer. For example, in the manufacture of disposable diapers a degree of elasticity of the fabric will assist in conforming it to the body contours of the wearer. Further, it is often desired that the composite material should have a soft hand and feel. It is therefore desirable that the bonding of the elastic web to the other web or webs of the laminate be done without the provision of an adhesive which would tend to make the resultant composite stiff.

In the forming of elasticized fabrics having gathers, it has always been necessary that the elastomeric or elastic substrates be of a sufficient

strength and increased basis weight to overcome the resistance of various types of webs to form the gathers. This of course limits the choice of gatherable webs to only those having great flexibility with little or no stiffness and being of low basis weight. Otherwise the basis weight of the elastomeric or elastic substrate must be increased so that the contracting force is great enough to form gathers in the chosen material. This increased basis weight, however, increases the cost of the elasticized fabric, and the resulting increased stiffness of the fabric has a deleterious affect on the hand and drape of the fabric.

As described in Taylor et al., U.S. Patent No. 4,692,368, "stretch-bonded laminates" may be formed by joining at least two nonwoven webs, one of which is elastic and at least one of which is nonelastic. The elastic nonwoven web is joined to the nonelastic web while the elastic nonwoven web is in an elongated condition due to an applied tensioning force. Upon removal of the tensioning force, after the joining of the webs, the elastic nonwoven web will attempt to recover to its unstretched condition and thereby start to gather the nonelastic nonwoven web. It is at this point, in the web gathering process, that the highest or largest contracting force is required and used in the contracting of the "stretch bonded laminate" to form gathers during its first cycle of gathering. After the gathers have been formed for the first time, any further repetition of elongation and contraction will not require as high a contracting force to relax the stretch bonded laminates and reform previously shaped gathers. The stiffer and less flexible the nonelastic nonwoven webs become, the greater must be the recovering force, which results in heavier, thicker, and less drapable elastic nonwoven

webs.

As indicated, a stretch bonded web having an ungathered web joined to a stretched melt blown elastic fibrous web must have a stretched elastic fibrous web having a contracting force strong enough to form gathers in said ungathered web by overcoming the resistance of the ungathered web to having gathers formed in itself. The fibrous elastic web consists of melt blown random laid fibers that have been subjected to thermal and oxidative degradation and have lay down problems inherent in the melt blown process such as streaks, and thick and thin areas which are compensated for by increasing the basis weight of the fibrous elastic web to ensure the proper gathering of the gatherable web. There also are many types of nonelastic nonwoven webs that would be useful as the gatherable web in an elastic fabric but are either too difficult to gather by the contracting force of the fibrous elastic web or the elastic web has to have an increased basis weight to overcome the resistance to gathering by the nonelastic web, which would make the cost of the elastic fabric exorbitantly high. In addition, there are nonelastic webs having stiffness and toughness so great that it is not practical to form a melt blown elastic fibrous web with strong enough contractive forces to gather them.

This invention relates to improvements to the inventions set forth above and to solutions to the problems raised or not solved thereby.

Summary of the Invention

As stated, in the forming of elasticized fabrics without the use of pregathered webs it is necessary that the elastomeric or elastic substrates be of a sufficient strength and increased basis weight to overcome the resistance of various types of webs to

form gathers. This of course limits the choice of gatherable webs to only those having great flexibility with little or no stiffness and being of low basis weight, or alternately, increasing the basis weight of the elastomeric or elastic substrate until the contracting force is great enough to form gathers in the chosen material, thereby increasing the cost of the elasticized fabric with the increased stiffness having a deleterious affect on the hand and drape of the fabric. By forming permanent pregathered patterns of creases and crimps in webs, many more durable and stronger webs such as films and heavy abrasion resistant webs of the melt spun or hydroentangled types become available for use in elasticized fabrics. Since these permanent creases and crimps have, upon being elongated, a contracting force of their own, it is now utilized in helping or adding to the contracting or relaxing force of the elastomeri[illegible]astic substrate in the forming of gathers in the [illegible]tion and contraction of elasticized fabrics or c[illegible]tes. This allows the reduction of elastomeric materials required in the elastomeric substrate to contract the elasticized web upon the relaxing of the elongating force. If the pregathered web is elongated and stretched beyond its elastic limit to a point where molecular orientation takes place, the pregathered creases and crimps will become distorted and will disappear or rupture upon continued elongation.

Stated another way, by forming permanent pregathered patterns of creases and crimps in webs, many more durable and stronger webs such as films and heavy abrasion resistant webs of the melt spun or hydroentangled types become available for use in elasticized fabrics. Since these permanent creases and crimps have, upon being elongated, a contracting force

of their own, that very contracting force is now utilized in helping or adding to the contracting or relaxing force of the elastomeric or elastic substrate in the forming of gathers in the relaxation and contraction of elasticized fabrics or composites. This allows the reduction of expensive elastomeric materials required in the elastomeric substrate to contract the elasticized web upon the relaxing of the elongating force.

An advantage of the instant invention, then, is the ability to form extremely light weight elasticized fabrics, laminates, or composites by combining low basis weight, highly elastic stabilized continuous filament webs having high extensibilities, low modulus and low tensile sets, to a low basis weight pregathered web which is at least partially self gathering. Because of the low modulus and low tensile set of the continuous elastomeric filaments in comparison to the thermoplastic urethanes, it is possible to design gathered elastic closures that are gentler and less constrictive to the user. At the low end of this range it is important that the elastic filaments are strong enough to provide the retentive force needed to maintain a secure fit of the garment to the wearer. And the high end of the elongation range should not be so strong as to cause strangulation of limbs or welting and/or discomfort to the user.

Rather than forming elasticized webs using melt blown elastomeric fibrous webs or perforated elastic films as in prior art methods, it is an object of this invention to use lower cost, melt spun continuous elastomeric filaments for several reasons. The first reason, beyond the clear cost savings attributable to the material itself, is that the melt spun filaments have higher tensile strengths than do melt

blown fibers formed of like materials. Therefore less material is required to obtain the same result. Moreover, the prior art use of a web form to elasticize the fabric, rather than using individual continuous filaments as in the present invention, prevents the use several different materials in forming the elasticized fabric. That is, the present invention permits the intermingling of elastomeric and non-elastic continuous filaments of various areas, sizes, and shapes, and the placing of these continuous filaments in predetermined locations and concentrations and the predetermined laydown direction of the continuous filaments. Also, individual continuous elastomeric filaments can be stretched intermittently in total or in selected portions to provide discrete areas with more elasticity than surrounding adjacent areas, and other discrete areas can be provided with more elastomeric filaments in a predetermined intermittent pattern than adjacent areas. Since the individual continuous filaments are cooled by temperature controlled feed rolls and draw rolls there is no need for a holding box which is required in the prior art to cool melt blown elastomeric webs for a length of time to avoid its cooling in a stretched condition wherein the elastic web would lose all or a considerable proportion of its ability to contract from the stretched condition it had during bonding.

Great savings can be made by the use of longitudinal elastomeric filaments in the manufacture of single direction stretch fabrics used in elastic bandages and similar products.

The heat set crimping or preset crimping of pregatherable webs with temperature controlled crimping rolls puts a permanent set in difficult to gather webs, enabling the use of lighter weight lower cost

elastomeric substrates. As indicated above, this permanently set pattern of gathers in the pregathered web has an inherent contracting force of its own which aids in the relaxation and contraction of elasticized fabrics or composites.

According to the invention a creping or gathering process is performed on an elongatable but relatively nonelastic web. This gathering process may be performed by any of a number of creping apparatus commercially available. Once the nonelastic web is gathered, it is joined to a nonwoven elastic web to form an elasticized gathered nonwoven fabric. This fabric is then subjected to tension and thus stretched and elongated so as to remove most or substantially all of the gathers from the pregathered web. Finally, tension is removed from the elasticized nonwoven fabric so as to relax the fabric, and thereby reform some or all of the gathers of the nonelastic web.

According to the instant invention, these pregathered substrates may be joined to untensioned, lightly tensioned, or substantially tensioned melt spun continuous elastomeric filamentary substrates with a resultant increases in their contracting and relaxing capabilities and a decrease in cost by the utilization of a more efficient use of elastomeric material which in turn immensely improves the hand, drape, appearance, and uniformity of porosity opacity and basis weight.

The elasticized fabrics of the present inventions include one or more plies of various fibrous webs or films bonded to non-random laid continuous elastomeric filaments or to combinations of elastomeric filaments and elongatable but relatively non-elastic continuous filaments which are stabilized with a deposition of melt blown or sprayed polymeric fibers.

Other objects and advantages of the invention will become apparent hereinafter.

Description of the Drawing

Fig. 1 is a side schematic view of an apparatus constructed to practice one embodiment of the invention, by use of a Micrex-type creper.

Fig. 2 is a side schematic view of an apparatus similar to that shown in Fig. 1, including apparatus for applying another web to the fabric.

Fig. 3 is a side schematic view of an apparatus similar to that shown in Fig. 2, including apparatus for applying additional materials to the fabric.

Fig. 4 is a side schematic view of an apparatus constructed to practice a different embodiment of the invention by use of meshing creping rolls of different sizes and gear shapes.

Fig. 5 is a side schematic view of an apparatus constructed to practice yet another embodiment of the invention by use of a set of corrugating endless chains in addition to microcreping rolls.

Description of the Preferred Embodiments

The terms "melt blowing" and "melt spraying" are herein used interchangeably and defined as the process where thermoplastic polymers are fed through one or more rows of spinnerets or spray nozzles forming molten streams which are then attenuated and fiberized with heated, pressurized air or gas streams. The heated, pressurized air or gas streams elongate or attenuate the molten extrudate, thereby forming fibers and or continuous filaments varying diameters from 0.2 microns or less to diameters of more than 1000 microns, and having lengths ranging from less than about 1/8" to continuous filaments having extreme lengths. The air or gas temperatures may range from over 900°F to less than 225°F at the spinneret or spray nozzles

depending upon the melt flow rate or the required degradation rate of the thermoplastic polymer or the melt temperature of the hot melt adhesive.

The term "melt spun" as used herein is defined as the process wherein continuous filaments are prepared by simultaneously spinning a multiple number of continuous filaments of a synthetic polymer such as polypropylene through a multiple number of spinning nozzles or spinnerets, preferably extending in one or more rows. The filaments are drawn pneumatically or mechanically from the spinneret and enter a travel zone which may be confined inside a covered chamber or chimney so as to introduce cooled, ambient, or heated air or other gas at a controlled temperature as required for draw processing or at least partially solidifying th[illegible]ments.

The terms "draw", "drawn", "drawable", "molecularly drawable", and "molecularly oriented" are herein used interchangeably and are defined as the process which takes place when an unoriented crystalline polymer is subjected to an external stress. Due to the application of that stress, the polymer undergoes a rearrangement of the crystalline material, wherein the polymer chains align in the direction of the applied stress, at which time the physical properties of the sample change markedly.

The terms "filament", "longitudinal filament", "continuous filament", and "melt spun filament" are herein used interchangeably and are defined for the purposes hereof as melt spun continuous filaments which have not been intentionally broken or cut, formed from a number of orifices in a spinneret plate, and are not limited as to size or shape.

The terms "elastic" and "elasticized" are herein used interchangeably and are used to describe

articles which have been made stretchable and contractable with the use of elastomeric materials in their preparation. These articles may be prepared wholly from elastomeric materials or may be comprised of elastomeric materials combined with relatively nonelastic materials.

The term "recovery" is used in reference to the ability of an elongated material to return to its original length before elongation, after relaxation and contraction. Highly elastomeric materials approach 100% recovery after elongation and relaxation and have stretchabilities ranging from about 10% to over 900% of their relaxed length, whereas many nonelastic but elongatable materials approach 0% recovery after elongation and molecular orientation after relaxation and contraction. The term recovery as used herein refers to the contraction of a stretched or elongated material upon termination of the elongating force subsequent to the stretching or elongating of a material by the elongating force.

The terms "elongatable but relatively nonelastic" and "elongatable but nonelastic" are herein used interchangeably and concern materials, composites or webs which after elongation remain extended, to varying degrees, upon release of the elongating force. For instance, a material, web or filament having a relaxed length of 2 inches may be elongated to a length of 2.2 inches, for an elongation of at least 10% of its original relaxed length. If, upon release of the elongating force, followed by relaxation and contraction, the length of the material is 2.1 inches, the material is elongatable but nonelastic. This relaxed contracted length of 2.1 inches represents a recovery of 50% of its elongation for a permanent increase of its length of 0.1 inches or a length increase of 5% of its original relaxed length. An elongatable but relatively nonelastic filament or fiber is herein defined as a filament or fiber formed from a material having a recovery varying from 0% to about 50%, or permanent elongations varying from about 50% to 100% of their elongated lengths.

The terms "heat set crimp", "preset crimp" and "pregather" are herein defined as permanent gathers, crimps, crepes, wrinkles, puckers, corrugations, or any other suitable gathering type pattern, which are permanent creases or folds formed in webs or substrates by crimping or corrugating rolls. The permanent crimping is accomplished by the molecular orientation which takes place by the crimp drawing of webs or substrates during crimping at ambient temperatures or the softening and cooling of the webs or substrates as they pass through temperature controlled crimp rolls.

The most important qualities required in the design of elasticized disposable products, such as diapers, wherein leg or waist band dimensions may need to increase or stretch to from 50 to 100% or more during use, are continuous elastomeric filaments, fibers or films having high extensibilities, low moduli, and low tensile sets. Shell Chemical Co.'s new series of Kraton polymers such as G2730X and D2120X have stretch ratios up to 7 or greater and are easily extruded into films or continuous elastomeric filaments, making them well suited for the elastication of disposable incontinence products or disposable garments. The modulus of Kraton polymer films and filaments can be as low as one tenth the modulus of competing urethane materials, making them ideal for use in disposable fabrics and other products. Their high elasticity or extensibility combined with the unique characteristic of having

a low modulus and a very low tensile set allow the design of gathered elastic closures that are gentler and less constrictive with less discomfort for the user of disposable diapers or adult incontinence products.

Applicant has found that pregathering the gatherable substrate or material substantially reduces the contracting and relaxing force required to form the gathers upon the release of the tensioning force on the elasticized fabric. In fact, as previously indicated, in some cases pregathering assists the contracting force of the elasticized fabric. The pregatherable patterns may vary and take on various forms such as corrugated, crimped, creped, wrinkled, puckered or any other suitable gathering type pattern depending upon the materials comprising the gatherable substrate. The method and type of pregathering will vary with the physical properties of the particular substrate or gatherable material.

For instance, a low basis weight, very pliable substrate may only require a passage through a Micrex-type creper 10 prior to joining an elasticized substrate, as shown in Figs. 1, 2 and 3. Machines such as these are produced and sold by the Micrex Corp. of Walpole, Massachusetts. On those machines, the creping is formed on a main roll 12 where the web 14 to be treated is driven by the surface of the rotating main roll pressing against a stationary primary surface 16. The web 14 is doctored off the roll 12 between a rigid retarder 18 and a flexible retarder 20 which furnish the resistance required to form a creped web 22. By adjusting various controls, the uniformity, degree of compaction, and crepe-cross section can be varied to obtain the desired results and characteristics of the material being creped or pregathered.

As the gatherable substrate basis weight increases or the pliability decreases or both, it may become necessary to pass the substrate through a pair of meshing tooth rollers 24 and 26, as shown in Figs. 4 and 5, and as taught in Sukenik, U.S. Patent No. 4,531,996, Sabee, U.S. Patent No. 4,153,664 and Sabee, U.S. Patent No. 4,223,063, wherein permanent crimps are formed to pregather the web. The disclosures of these patents are incorporated herein by reference. As shown in Fig. 4, the tooth form can be of any shape from sharp pointed teeth 28 which impart crimps to the web, to a rounded sinusoidal form 30. This latter form, depending upon the closeness of the fit between the teeth, can be used to cause pregathering without forming permanent crimps to the web and is appropriate for cases wherein the elasticized fabrics require a very high elongation of about 300% or more. Also, the teeth may be heated to facilitate the formation of permanently set gathers.

Pregathering without forming permanent or preset crimps may also accomplished by passing webs through non-crimping corrugating chains 32, carrying corrugating rolls 34 such as shown in Fig. 5 and as disclosed in Steinmann et al., U.S. Patent No. 3,102,776, the disclosure of which is incorporated herein by reference. This pregathering with the use of the corrugating rolls 34 and chains 32 is also appropriate for cases wherein the elasticized fabrics require a very high elongation of about 300% or more, since the crimped pregathered substrate is further gathered by this arrangement without further permanent crimping.

The permanently crimped pregathered substrate now has elastic properties, in that it requires a stretching force to elongate it and upon relaxing of

the stretching force the crimped pregathered substrate contracts. This means that a reduced contracting force is required of the elasticized web applied to the pregathered substrate, to relax and contract the resulting elasticized fabric, as compared to an ungathered substrate wherein gathers are formed solely by the contracting force of an applied fibrous web of stretched melt blown elastomers.

The utilization of the inherently higher tensile strength continuous elastomeric filaments, oriented in preselected directions and joined to pregathered substrates, substantially increases the contracting and relaxing capabilities of resulting elasticized fabric. The continuous filaments upon being laid in a predetermined lineal direction parallel to the fabric direction of elongation will have 100% of the continuous elastomeric filaments developing a contracting or relaxing force, whereas melt blown random laid elastomeric fibers in addition to being subjected to thermal and oxidative degradation have only a portion of the random laid fibers laid in the direction of elongation of the elasticized fabric, the remaining elastomeric fibers lying in various random directions.

Referring now again to Figs. 1 through 3, there is shown a web 14 being formed of melt blown fibers 36 from a melt blown fiber die 38. While this web 14 is shown being formed on a drum 40, web 14 could just as easily be prefabricated, and be fed from a roll. If prefabricated, the web 14 may be any suitable prefabricated web including but not limited to dry or wet laid webs, spun bonded webs, melt blown webs, air laid webs, hydroentangled webs, film, spun laced webs, fibrillated films, needle punched webs, high loft fabrics, and stabilized, non-random laid, continuous filament webs as described in Sabee '064.

From there, as indicated above, web 14 is creped in a Micrex-type creper and, resulting in the creped web 22.

At the same time, an array 42 of melt spun continuous elastomeric filaments is formed from an elastomeric melt spun extrusion die 44 and passes into the nip of a pair of temperature controlled feed rolls 46. From there, the array of filaments 42 is stabilized by the application of melt blown fibers 48 from a melt blown fiber die 50. Thereafter, the array of continuous filaments 42 is joined to the creped web 22, preferably by means of the application of melt blown adhesive fibers 52 from a melt blown adhesive die 54. As shown in Figs. 1 through 3, the melt blown adhesive fibers 52 may be applied to both the array of continuous filaments 42 and the creped web 22 simultaneously. Alternatively, adhesive fibers 52 may be applied to each separately.

Once adhesive fibers 52 are applied, the array of continuous filaments 42 is joined to the creped web 22 by passage through the nip of two joining rolls 54, to produce an elasticized fabric 56. This fabric is then subjected to tension such as by draw rolls 58 so as to remove substantially all of the gathers or crepes from the creped web 22, while stretching the array of continuous filaments 42. After draw rolls 58, the fabric 56 is relaxed, and the tension thereon released so as to reform at least some of the gathers of the original creped web 22. Thereafter, the resulting wavy but still elastic fabric 60 is accumulated on a roll 62 by a two drum winder 64.

An alternative embodiment of this invention is shown in Fig. 2. As shown in that figure, elasticized fabric 56 is arrived at in identically the same way as shown in Fig. 1. Thereafter, a substantially

non-elongatable web 66, whether prefabricated and unwound from a drum 68, or formed of melt blown fibers on drum 68, is applied to the continuous filaments side of the fabric 56 as it is drawn and elongated so that the gathers are removed from the pregathered web 22. If prefabricated, the web 66 may be any suitable prefabricated web including but not limited to dry or wet laid webs, spun bonded webs, melt blown webs, air laid webs, hydroentangled webs, film, spun laced webs, fibrillated films, needle punched webs, high loft fabrics, and stabilized, non-random laid, continuous filament webs as described in Sabee '064. Web 66 may be applied to the array 42 of continuous filaments by any suitable means such as the application of melt blown adhesive fibers 70 from a melt blown adhesive die 72. Thereafter, the resulting three-ply fabric 74 may now be pin bonded by pin bonding apparatus 76. As is conventional, pin bonding apparatus 76 may include an ultrasonic horn 78 and an embossed roll 80. As in Fig. 1, the resulting fabric 82, now pin bonded, is relaxed so as to reform at least some of the gathers, and accumulated on a roll 62 by a two drum winder 64.

Turning now to Fig. 3 for yet another slightly modified embodiment, there is shown an additional melt blown fiber die 84 melt blowing fibers onto the side of the array of continuous filaments opposite that on which die 50 is melt blowing fibers 58. The purpose of this additional deposition of melt blown fibers is to further stabilize the array of continuous filaments 42. After this additional deposition of melt blown fibers, the rest of the process is the same as described in connection with Fig. 2.

Figs. 4 and 5 show basically the same process, the only difference being the method and apparatus for gathering the web 14. That is, referring

first to Fig. 4, as indicated above, there is shown a web 14 being formed of melt blown fibers 36 from a melt blown fiber die 38. While this web 14 is shown being formed on a drum 40, web 14 could just as easily be prefabricated and fed from a roll. From there, as indicated above, web 14 is gathered by means of meshing tooth rollers 24 and 26. In the particular embodiment shown in Fig. 4, the web 14 is first passed through meshing toothed rollers 24 which have sharp pointed teeth 28 to impart permanent crimps to the web. Thereafter, the crimped web 22 is passed through the second set of meshing toothed rollers 26 which have teeth 30 with a rounded sinusoidal form, and which do not actually contact each other. This latter structure causes pregathering without forming further permanent crimps to the already-crimped web 22 and results in a doubly-gathered web 23, for cases wherein the final elasticized fabrics are intended to permit a very high elongation of about 300% or more.

As indicated with respect to Figs. 1 through 3, an array 42 of melt spun continuous elastomeric filaments is simultaneously formed from an elastomeric melt spun extrusion die 44 and passes into the nip of a pair of temperature controlled feed rolls 46. From there, the array of filaments 42 is joined to the doubly-gathered web 23, preferably by means of the application of melt blown adhesive fibers 52 from a melt blown adhesive die 54. Once adhesive fibers 52 are applied, the array of continuous filaments 42 is joined to the doubly-gathered web 23 by passage between sinusoidal meshing toothed rollers 26 and an application belt 88, to produce a highly elasticized fabric 90. This fabric 90 is then subjected to tension such as by sets of draw rolls 92 so as to remove substantially all of the gathers or crepes from the

doubly-gathered web 23, while stretching the array of continuous filaments 42. Some of the draw rolls 92a may be embossed so as to pin bond the doubly-gathered web 23 and the array of continuous filaments 42 together. The fabric 90 is relaxed, and the tension thereon released so as to reform at least some of the gathers of the original creped web 22. The resulting wavy but still elastic fabric 94 is accumulated on a roll 62 by a two drum winder 64.

The structure shown in Fig. 5 is basically the same as that shown in Fig. 4, the only material exception being that the doubly-gathered web 23, rather than being arrived at by use of the sinusoidal meshing toothed gears 26 of Fig. 4, is produced by the non-crimping corrugating chains 32 of Fig. 5. As indicated previously, these chains 32 carry corrugating rolls 34, which impart additional gather to the crimped web 22. It will be noted that the web 14 to be gathered is shown in Fig. 5 to be formed by deposition onto a foraminous belt 96 rather than the drum 40 shown in Figs. 1 through 4, and that the doubly-gathered web 23 is applied to the filaments 42 by an application drum 98 rather than the application belt 88 shown in Fig. 4. These differences are optional and form no part of the invention.

In another embodiment, the element 44 represents a machine as disclosed in Sabee '064 which prepares a cross-laid laminate 42 of nonrandom-laid continuous filaments, wherein at least one curtain of continuous filaments oriented in a first direction is joined to another curtain of continuous filaments oriented in a second direction transverse to the first direction. Alternatively element 44 represents a roll of prefabricated laminate 42.

The term "melt blown fibers" is herein used

to refer to fiber lengths varying from short fibers to substantially continuous length filaments. Melt blown fibers may be adhesive fibers from materials including pressure sensitive, elastomeric, pressure sensitive elastomeric, hot melt or any fiberizable thermoplastic polymer, co-polymer or blend of polymers.

The continuous filaments 42 are prepared by simultaneously spinning a multiple number of continuous filaments of a synthetic polymer such as a polypropylene or an elastomeric polymer through a multiple number of spinning nozzles or spinnerets, preferably extending in one or more rows. Upon exiting the spinnerets the filaments enter a controlled temperature chamber and are drawn away from the spinneret orifice at a greater rate than the rate of extrusion. Thus is effected a substantial draw down of the filaments in the molten state prior to solidification thereof. The solidified filaments having a low degree of molecular orientation are then subjected to a mechanical draw down with draw rolls under closely controlled temperature and velocity conditions thereby imparting a much higher degree of molecular orientation to the continuous filaments.

The melt blowing of adhesive fibers is performed by the same technique as in an article by Van A. Wente entitled "Superfine Thermoplastic Fibers" appearing in Industrial and Engineering Chemistry, Vol. 48, No. 8, pp. 1342 to 1346, and have diameters ranging from less than 0.5 microns to more than about 250 microns. These adhesive fibers are made by extruding a molten thermoplastic adhesive material through a plurality of fine die capillaries as a molten extrudate of filaments into a high velocity gas stream which attenuates the filaments of molten adhesive material to reduce their diameter to the above

stated range in the formation of microfibers or filaments. Any fiberizable hot melt adhesive material is suitable in the formation of adhesive fibers to be used in the intermingling and the joining of stratified fibrous fabrics. Elastomeric adhesives, pressure sensitive adhesives, pressure sensitive hot melts, viscoelastic hot melts, self-adhering elastic materials and conventional hot melt adhesives are some of the adhesives suitable for forming adhesive fibers. It is to be understood, however, that the present invention is not to be limited to these specific adhesives.

As has been previously stated, the melt blown adhesive fibers do not stiffen the fibrous stratified fabrics as do the roller applied or coated adhesives. These latter adhesives often fill crevices and interstices between the fibers of the fibrous layer or web and, after sol''ification, bind groups of fibers together, which sti. 'n the fibrous layer and has a deleterious effect on the hand and drape. The melt blown adhesive fibers on the other hand act as do the fibers of the layered fibrous web and not as sprays such as paint sprays, wherein small droplets of paint are emitted from a gun. The melt blown fibers, being flexible and of small diameter, are turbulently entangled with the fibrous web fibers and form bonds at their intersections with these fibers. These intersectional adhesive bonds behave similarly to fusion bonds with no noticeable stiffness of the composite fabric. They also provide the additional feature that the elastomeric adhesive fibers stretch or elongate under stress.

Other materials for use in forming indepth, joined, stratified webs such as those disclosed here are polyolefins such as polypropylene, polyethylene,

polybutane, polymethyldentene, ethylenepropylene copolymers; polyamides such as polyhexamethylene adipamide, poly-(oc-caproamide), polyhexamethylene sebacamide, polyvinyls such as polystyrene, thermoplastic elastomers such as polyurethanes, other thermoplastic polymers such as polytrifluorochloroethylene and mixtures thereof; as well as mixtures of these thermoplastic polymers and co-polymers; ethylene vinyl acetate polymers, synthetic polymers comprising 40% or more of polyurethane; polyetheresters; polyetherurethane; polyamide elastomeric materials; and polyester elastomeric materials S-EB-S Kraton "G" Block co-polymers and Kraton GX 1657 Block co-polymers as furnished by Shell Chemical Company; polyester elastomeric materials under the trade name "Hytrel" from the Dupont Company; polyurethane elastomeric materials under the trade name "Estane" from B. F. Goodrich and Company and polyamide elastoceric material under the trade name "Pebax" from Rilsam Company, including co-polymers, blends or various formulations thereof with other materials. Also included are viscoelastic hot melt pressure sensitive adhesives such as "Fullastic" supplied by H.B. Fuller and Company and other hot melt adhesives including pressure sensitive adhesives. Any of the fiber forming thermoplastic polymers including fiber forming hot melt adhesives, pressure sensitive adhesives, and viscoelastic hot melt pressure sensitive adhesives can be used for stabilizing the web or bonding the stabilized web to one or more cellulose webs, wood pulp webs, melt blown fibrous mats, or for laminating and bonding two or more stabilized webs to from laminates. The instant invention is not limited by the above polymers, for any thermoplastic polymer, co-polymer or mixture thereof capable of being melt blown into fibers or filaments is suitable. Any of

the thermoplastic elastomers which are capable of being melt blown or melt spun are suitable for the manufacture of stretchable fabrics.

Unless the context requires otherwise, the continuous filaments used herein to form a curtain of continuous filaments can be of many materials, natural or manmade, ranging from textile threads or yarns composed of cotton, rayon, hemp, etc. to thermoplastic polymers. This invention is not limited to the use of any particular fiber, but can take advantage of many properties of different fibers. A curtain of continuous filaments or threads using multifilament threads of rayon or nylon is readily stabilized by depositing a layer of molten melt blown fibers or filaments on this continuous filamentary web. Upon cooling, the molten melt blown filaments become tacky and self-bond to the continuous rayon or nylon threads.

In the preferred embodiments, thermoplastic melt spun continuous filaments are used which involve continuously extruding a thermoplastic polymer through a spinneret thereby forming a curtain of individual filaments. Among the many thermoplastic polymers suitable for the continuous filaments are polyolefins such as polyethylene and polypropylene; polyamides, polyesters such as polyethylene terepthalate; thermoplastic elastomers such as polyurethanes; thermoplastic co-polymers; mixtures of thermoplastic polymers; co-polymers and mixtures of co-polymers; as well as the previously listed materials used herein for the melt blown fibers and filaments. However, the present invention is not limited to these materials, for any melt spinnable polymer is suitable, including all adhesive materials and spun bonded materials listed herein, and melt blown materials. Other spinnable thermoplastic elastomers which are suitable for

stretchable fabrics include but are not limited to polyester based polyurethane, and polyester type polyurethane polymeric fiber forming elastomers such as Texin 480A supplied by Mobay Chemical Company.

It will be understood that this invention is not to be limited to the aforementioned materials. On the contrary, it is intended that all fiberizable thermoplastic polymers, co-polymers and blends thereof, in addition to wood pulp or cellulose fibers and including staple fibers and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims are to be included.

While the apparatus, products and methods hereinbefore described are effectively adapted to fulfill the aforesaid objects, it is to be understood that the invention is not intended to be limited to the specific preferred embodiment of elasticized pregathered web set forth above. Rather, it is to be taken as including all reasonable equivalents within the scope of the following claims.

I claim:

1. An elastic composite material comprising:

at least one nonwoven elastic web having a multiplicity of substantially longitudinal continuous filaments of an elastomeric polymer and a multiplicity of melt blown fibers deposited on the longitudinal continuous elastomeric filaments, said melt blown fibers forming bonds at least at some of their intersections with said elastomeric filaments to thereby stabilize and fix said elastomeric filaments in the substantially longitudinal orientation of said web; and

at least one pregathered web joined to said nonwoven elastic web.

2. The elastic composite material of claim 1 wherein at least some of the melt blown fibers are elastomeric.

3. The elastic composite material of claim 1 wherein at least some of the melt blown fibers are elongatable but relatively nonelastic.

4. The elastic composite material of claim 1 wherein at least some of the melt blown fibers are adhesive fibers.

5. The elastic composite material of claim 1 wherein at least some of the melt blown fibers are thermoplastic materials.

6. The elastic composite material of claim 1 wherein at least some of the melt blown fibers are elastomeric materials and adhesives.

7. The elastic composite material of claim 1 wherein at last some of the melt blown fibers are pressure sensitive materials and adhesives.

8. The elastomeric composite material of claim 1 wherein at least some of the melt blown fibers are self-adhering elastic materials and adhesives.

9. The elastomeric composite material of claim 1 wherein at least some of the melt blown fibers are visco-elastic hot melt pressure sensitive materials and adhesives.

10. The elastic composite material of claim 1 wherein said longitudinal continuous elastomeric filaments are substantially parallel.

11. The elastic composite material of claim 1 wherein said continuous elastomeric filaments are bonded and stabilized in a nonrandom orientation with the deposition of melt blown fibers.

12. The elastic composite material of claim 1 wherein the nonwoven continuous filaments are bonded in a wavy, nonlinear, nonrandom identifiable repeating manner.

13. The elastic composite material of claim 1 wherein said nonwoven elastic web further includes a second multiplicity of continuous filaments, joined transversely to said multiplicity of continuous elastomeric filaments.

14. The elastic composite material of claim 1 wherein said elastic web is thermally bonded to said pregathered web.

15. The elastic composite material of claim 1 wherein said elastic web and said pregathered web are joined with adhesive fibers.

16. The elastic composite material of any one of claims 14 and 15 wherein said elastic web and pregathered web are thermally pin bonded together.

17. The elastic composite material of claim 16 wherein the nonwoven elastic web is under minimal tension and not elongated when it is being joined to said pregathered web.

18. The elastic composite material of claim 16 wherein the nonwoven elastic web is tensioned to

elongate it prior to joining with said pregathered web.

19. The elastic composite material of claim 16 wherein said elastic web is stretched and said pregathered web is elongated by an elongating force to at least about 65% to 90% of its original ungathered length when it is thermally pin bonded, under tension, and upon relaxation upon removal of the elongating force, at least partially returns to its original pregathered contours.

20. The elastic composite material of claim 19 wherein said elastic web is stretched and the pregathered web elongated up to at least about 400% of its original ungathered length by an elongating force, thereby molecularly orienting the pregathered web material, substantially increasing the web flexibility, and removing the original pregathered configurations, and which, upon relaxation and removal of the elongating force, form at least some new gathers of various profiles.

21. The elastic composite material of claim 1 wherein at least some of the continuous filaments are nonelastic.

22. An elasticized nonwoven fabric comprising at least one substantially elasticized web joined to at least one substantially nonelastic but elongatable gathered web wherein the gathers have been provided by means independent of the strength of tensile force of said elasticized web.

23. The elasticized nonwoven fabric of claim 22 further comprising a substantially nonelongatable gathered web joined to said elasticized web.

24. The elasticized nonwoven fabric of claim 22 further comprising adhesive fibers.

25. The elasticized nonwoven fabric of

claim 22 or 24 wherein said elasticized web includes a deposition of melt blown fibers.

26. The elasticized nonwoven fabric of claim 22 or 24 wherein said elasticized web comprises an elastic sheet.

27. The elasticized nonwoven fabric of claim 22 or 24 wherein said elasticized web comprises a perforated or porous elastic sheet.

28. The elasticized nonwoven fabric of claim 25 wherein said melt blown fibers are elastomeric.

29. The elasticized nonwoven fabric of claim 25 further comprising a previously gathered web bonded to said elasticized nonwoven web.

30. The elasticized nonwoven fabric of claim 25 wherein said elasticized nonwoven web is thermally pin bonded to a previously gathered web at a plurality of predetermined locations.

31. The elasticized nonwoven fabric of claim 30 further comprising adhesive fibers.

32. The elasticized nonwoven fabric of claim 30 further comprising thermal bonds.

33. The elasticized nonwoven fabric of claim 32 further comprising thermal pin bonds.

34. The elasticized nonwoven fabric of claims 25 wherein said elasticized web comprises a nonrandom continuous filament web stabilized with a deposition of melt blown fibers.

35. A method of producing an elastic fabric comprising the steps of:

a. pregathering at least one relatively nonelastic but elongatable web;

b. joining said pregathered nonelastic but elongatable web to a nonwoven elastic web thereby forming an elasticized gathered nonwoven fabric;

c. elongating said elasticized gathered nonwoven fabric, thereby stretching said nonwoven elastic web and removing substantially all of the gathers; and

d. relaxing said nonwoven elastic web and said elasticized nonwoven fabric thereby gathering said nonelastic web.

36. A method of producing an elastic fabric comprising the steps of:

a. providing a nonwoven elastic web;

b. pregathering at least one relatively nonelastic but elongatable web;

c. laminating and joining said pregathered nonelastic but elongatable web to said nonwoven elastic web, thereby forming an elasticized gathered nonwoven fabric;

d. elongating said elasticized gathered nonwoven fabric so as to stretch said nonwoven elastic web and remove substantially all of the gathers from said pregathered web; and

e. relaxing said elasticized nonwoven fabric so as to reform at least some of the gathers of said nonelastic web.

37. The method of claim 36 further comprising applying adhesive fibers to said pregathered web.

38. The method of claim 36 further comprising thermal bonding said pregathered web to said nonwoven elastic web.

39. The method of claim 38 wherein said thermal bonding comprises thermal pin bonding.

40. The method of claim 36 wherein said laminating and joining step includes applying adhesive fibers to said at least one nonwoven elastic web.

41. The method of claim 36 wherein said laminating and joining step includes applying adhesive

fibers and thermal bonding to said at least one nonwoven elastic web.

42. The method of claim 36 wherein said laminating and joining step comprises applying adhesive fibers and thermal bonding to said at least one pregathered relatively nonelastic but elongatable web.

43. The method of any one of claims 37, 40, 41 and 42 wherein the step of applying adhesives comprises applying thermoplastic materials.

44. The method of any one of claims 37, 40, 41 and 42 wherein the step of applying adhesives comprises applying elastomeric materials.

45. The method of any one of claims 37, 40, 41 and 42 wherein the step of applying adhesives comprises applying pressure sensitive materials.

46. The method of any one of claims 37, 40, 41 and 42 wherein the step of applying adhesives comprises applying self adhering elastic materials.

47. The method of any one of claims 37, 40, 41 and 42 wherein the step of applying adhesives comprises applying visco-elastic hot melt pressure sensitive materials.

48. The method of claim 36 wherein said nonwoven elastic web comprises at least one curtain of continuous longitudinal elastomeric filaments stabilized with a deposition of melt blown fibers.

49. The method of claim 36 wherein said nonwoven elastic web comprises at least one curtain of continuous filaments oriented in a first direction joined to another curtain of continuous filaments oriented in a second direction transverse to said first direction.

50. The method of claim 36 wherein said pregathering step comprises the formation of permanent creases or indentations in said relatively nonelastic

but elongatable web.

51. The method of claim 36 wherein said nonwoven elastic web comprises melt blown elastomeric fibers.

52. The method of claim 36 wherein said nonwoven elastic web comprises an elastic film.

53. The method of claim 52 wherein said elastic film is apertured.

54. The method of claim 52 wherein said elastic film is porous and breathable.

55. The method of claim 36 wherein said relaxing step permits the elongated gathers of the nonelastic web to return upon relaxation to substantially their original shape and length.

56. A method of producing an elastic fabric comprising the steps of:

a. forming one or more arrays of relatively elastomeric continuous filaments while simultaneously forming and pregathering at least one gas- or liquid-permeable web;

b. depositing at least one fibrous adhesive layer onto a first side of said array of elastomeric filaments and onto at least one side of said pregathered web;

c. joining said pregathered web with said first side of said array of elastomeric filaments to form a gathered elasticized fabric;

d. elongating said elasticized web to at least partially remove said gathers;

e. feeding said elongated elasticized fabric into a thermal bonding unit; and

f. relaxing said elasticized fabric to reform the previously formed gathers.

57. The method of claim 56 wherein said thermal bonding unit has at least one patterned roll

to form bonds in discrete isolated predetermined areas.

58. The method of claim 56 further comprising, after said joining:

depositing adhesive fibers onto the second side of said elastomeric filaments;

depositing adhesive fibers onto a prefabricated web;

joining said prefabricated web to said second side of said array of elastomeric filaments.

59. The method of claim 58 wherein the deposition of said adhesive fibers onto the second side of the elastomeric filaments and onto said prefabricated web are performed simultaneously.

60. A method of producing an elastic fabric comprising the steps of:

a. providing at least one nonwoven elastic web;

b. providing at least one pregathered relatively nonelastic but elongatable web having gathers, crimps, or corrugations;

c. elongating said at least one pregathered nonelastic web and said at least one nonwoven elastic web;

d. laminating and joining said at least one elongated pregathered web and said at least one stretched nonwoven elastic web, thereby forming a tensioned elastic nonwoven fabric;

e. relaxing said elastic nonwoven fabric thereby at least partially reforming the original gathers, crimps, or corrugations.

61. A non-woven fabric comprising:

a first plurality of continuous filaments at least partially of an elastomeric polymer, oriented substantially longitudinally;

a second plurality of continuous filaments at least partially of an elastomeric polymer, oriented substantially parallel to each other and deposited onto said first plurality in a transverse orientation and in a face-to-face relationship;

a plurality of melt blown fibers deposited at least on one side of said longitudinal and transverse continuous filaments, said melt blown fibers forming bonds at least at some of their intersections with said longitudinal and transverse filaments such that a stabilized array of said filaments in their respective orientations is generated; and

at least one pregathered web joined to said stabilized array.

62. A composite elasticized nonwoven fabric comprising continuous filaments, having at least one deposition of melt blown fibers, joined to at least one pregathered web.

63. A nonwoven fabric according to claim 62 wherein at least some of said continuous filaments are non-elastic but elongatable.

64. A nonwoven fabric according to claim 62 wherein at least some of said melt blown fibers are elastomeric.

65. A nonwoven fabric according to claim 62 wherein at least some of said melt blown fibers are nonelastic but elongatable.

66. A nonwoven fabric according to claim 62 wherein at least some of said melt blown fibers are adhesive fibers.

67. A nonwoven fabric according to claim 62 wherein said pregathered web is chosen from the group consisting of: fibrillated film, high loft fabric, dry laid web, wet laid web, film, spun bonded web, air laid web, melt blown web, spun laced web, hydroentan-

gled web, needle punched web or stabilized continuous filament non-random laid web.

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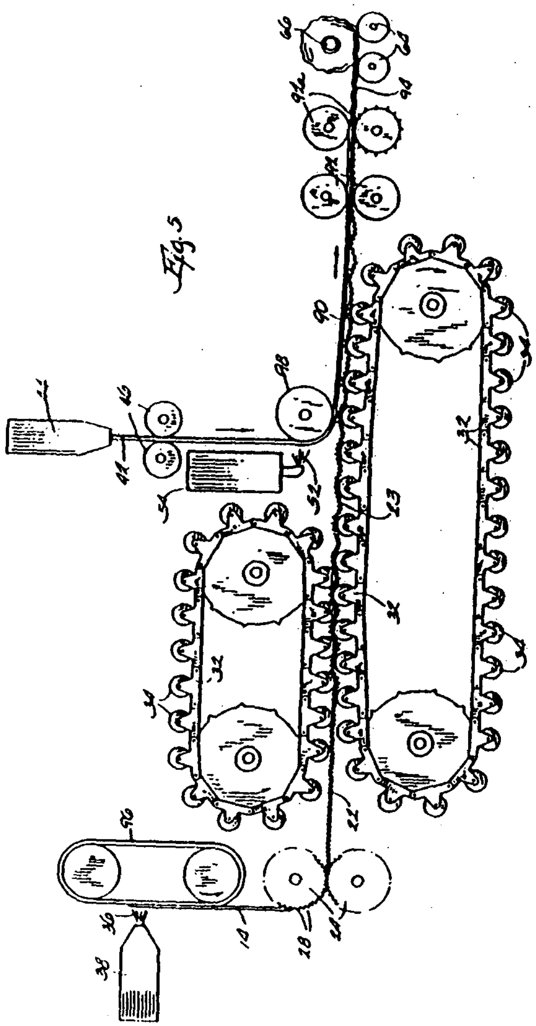

Fig. 5

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INTERNATIONAL SEARCH REPORT

International Application No PCT/US91/06685

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (5) : B32B 31/00

U.S. CL. : 156/164; 428/152, 288, 296

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	428/152, 288, 296; 156/164

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 4,657,802 (MORMAN) 14 APRIL 1987. See entire document.	1-15, 21-42, 48-67

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
15 OCTOBER 1991	28 OCT 1991
International Searching Authority	Signature of Authorized Officer
ISA/US	W.J. Van Balen W.J. Van Balen

Form PCT/ISA/210 (second sheet) (Rev.11-87)

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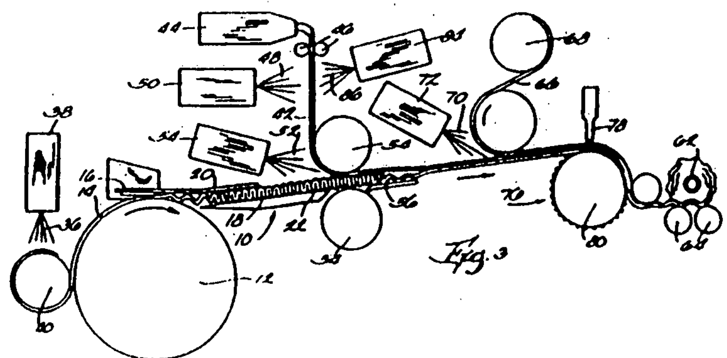

Fig. 3

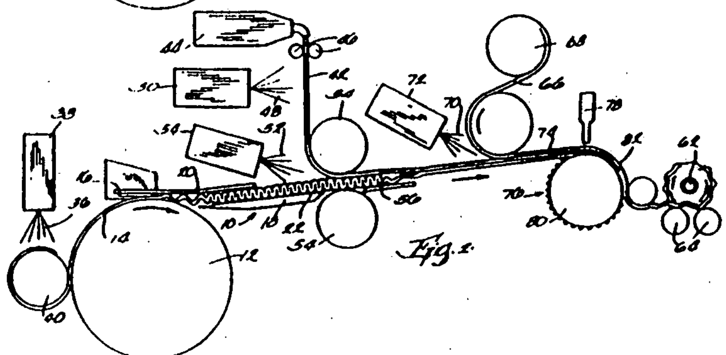

Fig. 2

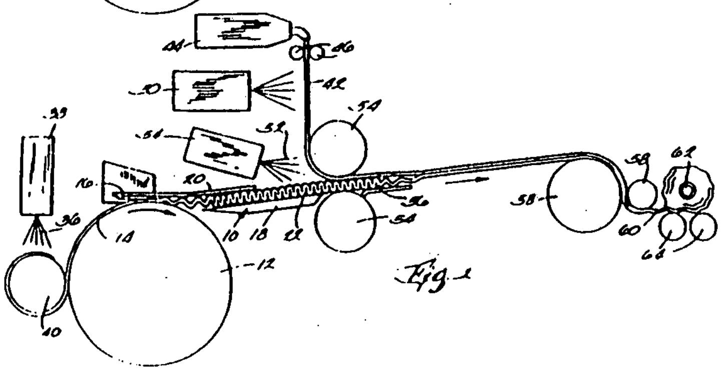

Fig. 1

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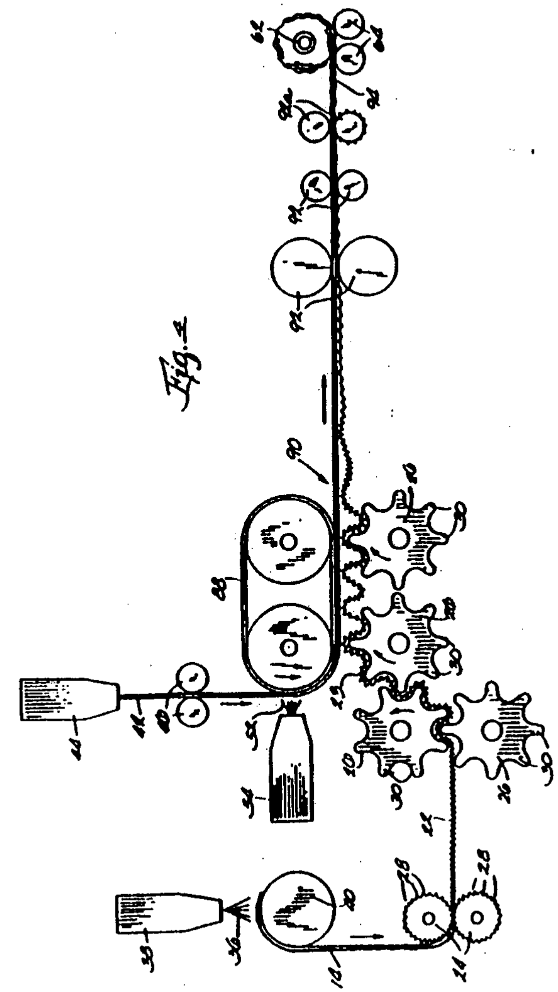

Fig. 4

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